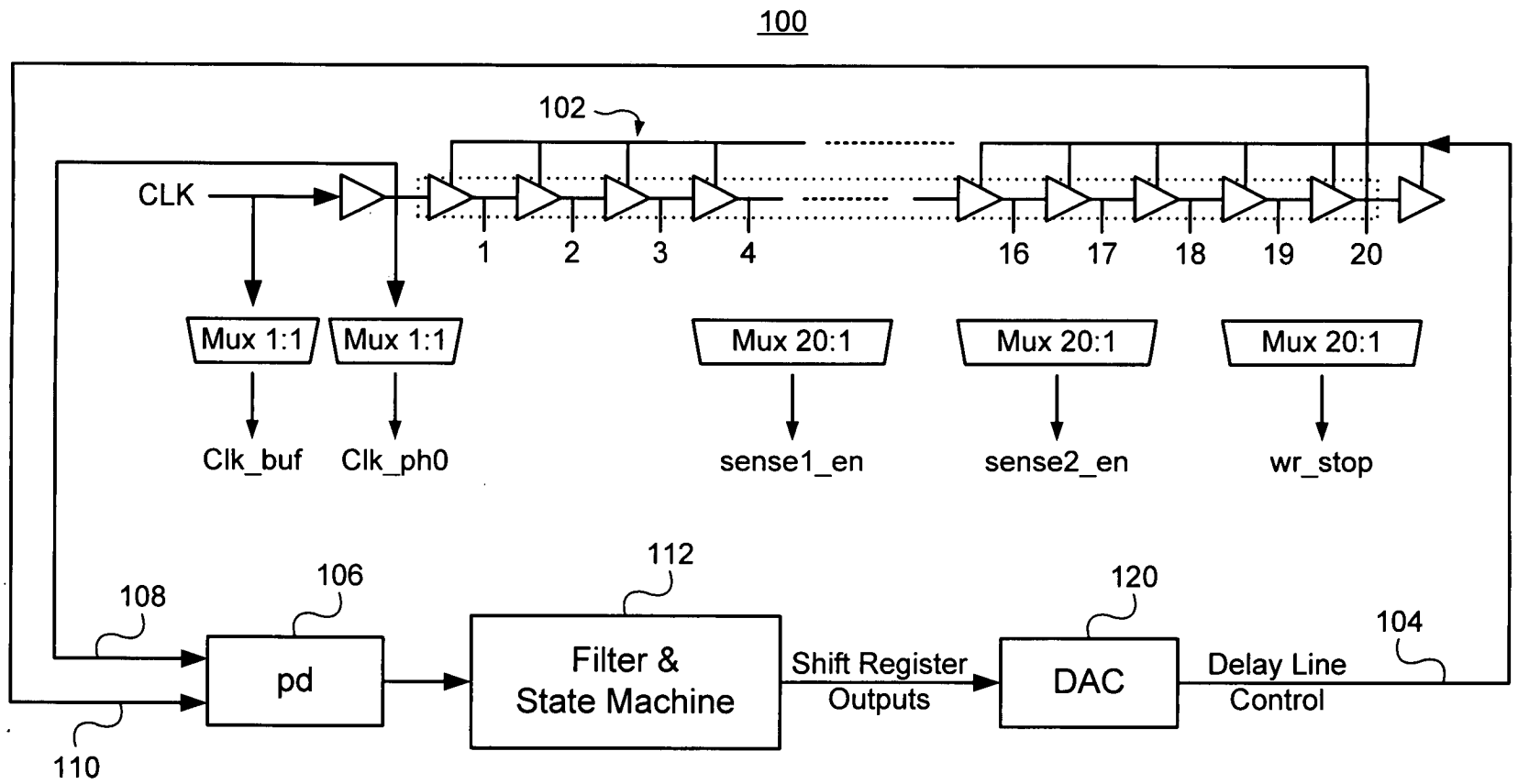
100
102
CLK
1
2
3
4
16
17
18
19
20
Mux 1:1
Mux 1:1
Mux 20:1
Mux 20:1
Mux 20:1
Clk_buf
Clk_ph0
sense1_en
sense2_en
wr_stop
108
106
112
120
104
pd
Filter &
State Machine
Shift Register
Outputs
DAC
Delay Line
Control
110

FIG. 1

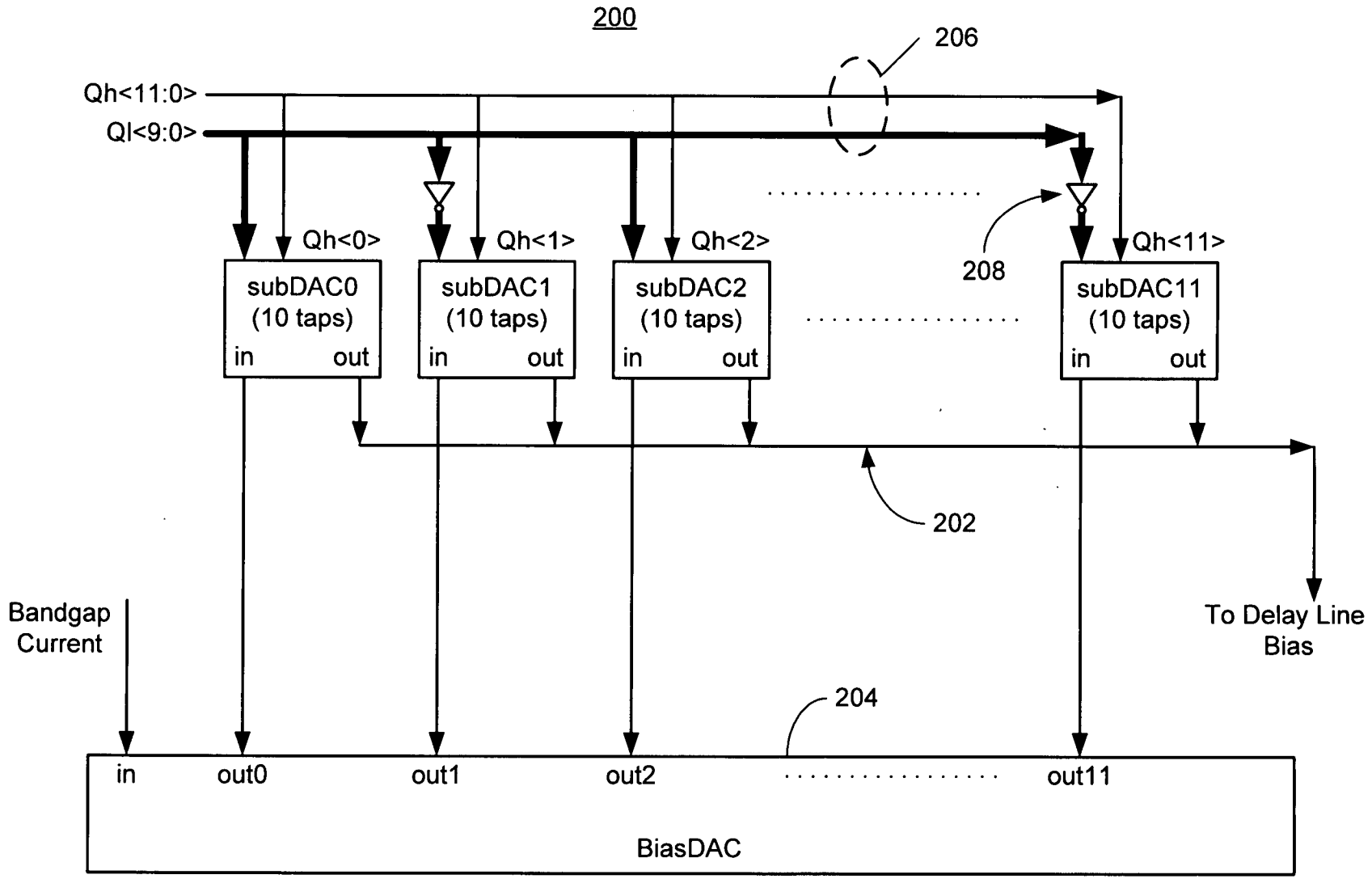
200
206
Qh<11:0>
Ql<9:0>
Qh<0>
Qh<1>
Qh<2>
208
Qh<11>
subDAC0
(10 taps)
in
out
subDAC1
(10 taps)
in
out
subDAC2
(10 taps)
in
out
subDAC11
(10 taps)
in
out
202
Bandgap
Current
To Delay Line
Bias
204
in
out0
out1
out2
out11
BiasDAC

FIG. 2

Code #	Qh<11:0>													Ql<9:0>										Current ((Iout-Imin)/Ibg)	Total Current (Iout/Imin)
	11	10	9	8	7	6	5	4	3	2	1	0		9	8	7	6	5	4	3	2	1	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	1
1	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	1	1	1.01
2	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	1	1	2.01	1.0201
3	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	1	1	1	3.0301	1.030301
4	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	1	1	1	1	4.060401	1.04060401
5	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	1	1	1	1	1	5.10100501	1.05101005
6	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	1	1	1	1	1	1	6.15201506	1.061520151
7	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	1	1	1	1	1	1	1	7.213535211	1.072135352
8	0	0	0	0	0	0	0	0	0	0	0	0		0	0	1	1	1	1	1	1	1	1	8.285670563	1.082856706
9	0	0	0	0	0	0	0	0	0	0	0	0		0	1	1	1	1	1	1	1	1	1	9.368527268	1.093685273
10	0	0	0	0	0	0	0	0	0	0	0	1		1	1	1	1	1	1	1	1	1	1	10.46	1.1046
11	0	0	0	0	0	0	0	0	0	0	0	1		1	1	1	1	1	1	1	1	1	0	11.56462213	1.115646221
12	0	0	0	0	0	0	0	0	0	0	0	1		1	1	1	1	1	1	1	1	0	0	12.68029047	1.126802905
13	0	0	0	0	0	0	0	0	0	0	0	1		1	1	1	1	1	1	1	0	0	0	13.8071155	1.138071155
14	0	0	0	0	0	0	0	0	0	0	0	1		1	1	1	1	1	1	0	0	0	0	14.94520878	1.149452088
15	0	0	0	0	0	0	0	0	0	0	0	1		1	1	1	1	1	0	0	0	0	0	16.094683	1.16094683
16	0	0	0	0	0	0	0	0	0	0	0	1		1	1	1	1	0	0	0	0	0	0	17.25565195	1.17255652
17	0	0	0	0	0	0	0	0	0	0	0	1		1	1	1	0	0	0	0	0	0	0	18.4282306	1.184282306
18	0	0	0	0	0	0	0	0	0	0	0	1		1	1	0	0	0	0	0	0	0	0	19.61253503	1.19612535
19	0	0	0	0	0	0	0	0	0	0	0	1		1	0	0	0	0	0	0	0	0	0	20.8086825	1.208086825
20	0	0	0	0	0	0	0	0	0	0	1	1		0	0	0	0	0	0	0	0	0	0	22.02	1.2202
21	0	0	0	0	0	0	0	0	0	0	1	1		0	0	0	0	0	0	0	0	0	1	23.24019004	1.2324019
22	0	0	0	0	0	0	0	0	0	0	1	1		0	0	0	0	0	0	0	0	1	1	24.47258198	1.24472582
23	0	0	0	0	0	0	0	0	0	0	1	1		0	0	0	0	0	0	0	1	1	1	25.71729784	1.257172978
24	0	0	0	0	0	0	0	0	0	0	1	1		0	0	0	0	0	0	1	1	1	1	26.97446086	1.269744609
25	0	0	0	0	0	0	0	0	0	0	1	1		0	0	0	0	0	1	1	1	1	1	28.24419551	1.282441955
26	0	0	0	0	0	0	0	0	0	0	1	1		0	0	0	0	1	1	1	1	1	1	29.5266275	1.295266275
27	0	0	0	0	0	0	0	0	0	0	1	1		0	0	0	1	1	1	1	1	1	1	30.82188382	1.308218838
28	0	0	0	0	0	0	0	0	0	0	1	1		0	0	1	1	1	1	1	1	1	1	32.1300927	1.321300927
29	0	0	0	0	0	0	0	0	0	0	1	1		0	1	1	1	1	1	1	1	1	1	33.45138366	1.334513837
30	0	0	0	0	0	0	0	0	0	1	1	1		1	1	1	1	1	1	1	1	1	1	34.78	1.3478
31	0	0	0	0	0	0	0	0	0	1	1	1		1	1	1	1	1	1	1	1	1	0	36.12784892	1.361278489
32	0	0	0	0	0	0	0	0	0	1	1	1		1	1	1	1	1	1	1	1	0	0	37.48917632	1.374891763
33	0	0	0	0	0	0	0	0	0	1	1	1		1	1	1	1	1	1	1	0	0	0	38.864117	1.38864117
34	0	0	0	0	0	0	0	0	0	1	1	1		1	1	1	1	1	1	0	0	0	0	40.25280708	1.402528071
35	0	0	0	0	0	0	0	0	0	1	1	1		1	1	1	1	1	0	0	0	0	0	41.65538407	1.416553841
36	0	0	0	0	0	0	0	0	0	1	1	1		1	1	1	1	0	0	0	0	0	0	43.07198683	1.430719868
37	0	0	0	0	0	0	0	0	0	1	1	1		1	1	1	0	0	0	0	0	0	0	44.50275561	1.445027556
38	0	0	0	0	0	0	0	0	0	1	1	1		1	1	0	0	0	0	0	0	0	0	45.94783208	1.459478321
39	0	0	0	0	0	0	0	0	0	1	1	1		1	0	0	0	0	0	0	0	0	0	47.40735932	1.474073593

Fig. 3A

	Qh<11:0>													Ql<9:0>										Current ((Iout-Imin)/Ibg)	Total Current (Iout/Imin)
Code #	11	10	9	8	7	6	5	4	3	2	1	0		9	8	7	6	5	4	3	2	1	0		
40	0	0	0	0	0	0	0	0	1	1	1	1		0	0	0	0	0	0	0	0	0	0	48.89	1.4889
41	0	0	0	0	0	0	0	0	1	1	1	1		0	0	0	0	0	0	0	0	0	1	50.37886373	1.503788637
42	0	0	0	0	0	0	0	0	1	1	1	1		0	0	0	0	0	0	0	0	1	1	51.8826161	1.518826161
43	0	0	0	0	0	0	0	0	1	1	1	1		0	0	0	0	0	0	0	1	1	1	53.401406	1.53401406
44	0	0	0	0	0	0	0	0	1	1	1	1		0	0	0	0	0	0	1	1	1	1	54.93538379	1.549353838
45	0	0	0	0	0	0	0	0	1	1	1	1		0	0	0	0	0	1	1	1	1	1	56.48470136	1.564847014
46	0	0	0	0	0	0	0	0	1	1	1	1		0	0	0	0	1	1	1	1	1	1	58.04951211	1.580495121
47	0	0	0	0	0	0	0	0	1	1	1	1		0	0	0	1	1	1	1	1	1	1	59.62997097	1.59629971
48	0	0	0	0	0	0	0	0	1	1	1	1		0	0	1	1	1	1	1	1	1	1	61.22623441	1.612262344
49	0	0	0	0	0	0	0	0	1	1	1	1		0	1	1	1	1	1	1	1	1	1	62.83846049	1.628384605
50	0	0	0	0	0	0	0	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	64.46	1.6446
51	0	0	0	0	0	0	0	1	1	1	1	1		1	1	1	1	1	1	1	1	1	0	66.10463182	1.661046318
52	0	0	0	0	0	0	0	1	1	1	1	1		1	1	1	1	1	1	1	1	0	0	67.76570996	1.6776571
53	0	0	0	0	0	0	0	1	1	1	1	1		1	1	1	1	1	1	1	0	0	0	69.44339888	1.694433989
54	0	0	0	0	0	0	0	1	1	1	1	1		1	1	1	1	1	1	0	0	0	0	71.13786469	1.711378647
55	0	0	0	0	0	0	0	1	1	1	1	1		1	1	1	1	1	0	0	0	0	0	72.84927516	1.728492752
56	0	0	0	0	0	0	0	1	1	1	1	1		1	1	1	1	0	0	0	0	0	0	74.57779974	1.745777997
57	0	0	0	0	0	0	0	1	1	1	1	1		1	1	1	0	0	0	0	0	0	0	76.32360956	1.763236096
58	0	0	0	0	0	0	0	1	1	1	1	1		1	1	0	0	0	0	0	0	0	0	78.08687747	1.780868775
59	0	0	0	0	0	0	0	1	1	1	1	1		1	0	0	0	0	0	0	0	0	0	79.86777807	1.798677781
60	0	0	0	0	0	0	1	1	1	1	1	1		0	0	0	0	0	0	0	0	0	0	81.67	1.8167
61	0	0	0	0	0	0	1	1	1	1	1	1		0	0	0	0	0	0	0	0	0	1	83.4866967	1.834866967
62	0	0	0	0	0	0	1	1	1	1	1	1		0	0	0	0	0	0	0	0	1	1	85.32156036	1.853215604
63	0	0	0	0	0	0	1	1	1	1	1	1		0	0	0	0	0	0	0	1	1	1	87.17477267	1.871747727
64	0	0	0	0	0	0	1	1	1	1	1	1		0	0	0	0	0	0	1	1	1	1	89.04651709	1.890465171
65	0	0	0	0	0	0	1	1	1	1	1	1		0	0	0	0	0	1	1	1	1	1	90.93697896	1.90936979
66	0	0	0	0	0	0	1	1	1	1	1	1		0	0	0	0	1	1	1	1	1	1	92.84634545	1.928463454
67	0	0	0	0	0	0	1	1	1	1	1	1		0	0	0	1	1	1	1	1	1	1	94.7748056	1.947748056
68	0	0	0	0	0	0	1	1	1	1	1	1		0	0	1	1	1	1	1	1	1	1	96.72255036	1.967225504
69	0	0	0	0	0	0	1	1	1	1	1	1		0	1	1	1	1	1	1	1	1	1	98.68977256	1.986897726
70	0	0	0	0	0	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	100.68	2.0068
71	0	0	0	0	0	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	0	102.6867634	2.026867634
72	0	0	0	0	0	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	0	0	104.7135944	2.047135944
73	0	0	0	0	0	1	1	1	1	1	1	1		1	1	1	1	1	1	1	0	0	0	106.7606937	2.067606937
74	0	0	0	0	0	1	1	1	1	1	1	1		1	1	1	1	1	1	0	0	0	0	108.828264	2.08828264
75	0	0	0	0	0	1	1	1	1	1	1	1		1	1	1	1	1	0	0	0	0	0	110.91651	2.1091651
76	0	0	0	0	0	1	1	1	1	1	1	1		1	1	1	1	0	0	0	0	0	0	113.0256385	2.130256385
77	0	0	0	0	0	1	1	1	1	1	1	1		1	1	1	0	0	0	0	0	0	0	115.1558582	2.151558582
78	0	0	0	0	0	1	1	1	1	1	1	1		1	1	0	0	0	0	0	0	0	0	117.3073802	2.173073802
79	0	0	0	0	0	1	1	1	1	1	1	1		1	0	0	0	0	0	0	0	0	0	119.4804173	2.194804173

Fig. 3B

	Qh<11:0>													Ql<9:0>										Current ((Iout-Imin)/Ibg)	Total Current (Iout/Imin)
Code #	11	10	9	8	7	6	5	4	3	2	1	0		9	8	7	6	5	4	3	2	1	0		
80	0	0	0	0	1	1	1	1	1	1	1	1		0	0	0	0	0	0	0	0	0	0	121.67	2.2167
81	0	0	0	0	1	1	1	1	1	1	1	1		0	0	0	0	0	0	0	0	0	1	123.8867152	2.238867152
82	0	0	0	0	1	1	1	1	1	1	1	1		0	0	0	0	0	0	0	0	1	1	126.1255976	2.261255976
83	0	0	0	0	1	1	1	1	1	1	1	1		0	0	0	0	0	0	0	1	1	1	128.3868688	2.283868688
84	0	0	0	0	1	1	1	1	1	1	1	1		0	0	0	0	0	0	1	1	1	1	130.6707527	2.306707527
85	0	0	0	0	1	1	1	1	1	1	1	1		0	0	0	0	0	1	1	1	1	1	132.9774754	2.329774754
86	0	0	0	0	1	1	1	1	1	1	1	1		0	0	0	0	1	1	1	1	1	1	135.3072654	2.353072654
87	0	0	0	0	1	1	1	1	1	1	1	1		0	0	0	1	1	1	1	1	1	1	137.6603533	2.376603533
88	0	0	0	0	1	1	1	1	1	1	1	1		0	0	1	1	1	1	1	1	1	1	140.036972	2.40036972
89	0	0	0	0	1	1	1	1	1	1	1	1		0	1	1	1	1	1	1	1	1	1	142.437357	2.42437357
90	0	0	0	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	144.86	2.4486
91	0	0	0	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	0	147.3086327	2.473086327
92	0	0	0	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	0	0	149.7817517	2.497817517
93	0	0	0	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	0	0	0	152.2796019	2.522796019
94	0	0	0	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	0	0	0	0	154.8024306	2.548024306
95	0	0	0	1	1	1	1	1	1	1	1	1		1	1	1	1	1	0	0	0	0	0	157.3504875	2.573504875
96	0	0	0	1	1	1	1	1	1	1	1	1		1	1	1	1	0	0	0	0	0	0	159.9240251	2.599240251
97	0	0	0	1	1	1	1	1	1	1	1	1		1	1	1	0	0	0	0	0	0	0	162.523298	2.62523298
98	0	0	0	1	1	1	1	1	1	1	1	1		1	1	0	0	0	0	0	0	0	0	165.1485637	2.651485637
99	0	0	0	1	1	1	1	1	1	1	1	1		1	0	0	0	0	0	0	0	0	0	167.800082	2.67800082
100	0	0	1	1	1	1	1	1	1	1	1	1		0	0	0	0	0	0	0	0	0	0	170.48	2.7048
101	0	0	1	1	1	1	1	1	1	1	1	1		0	0	0	0	0	0	0	0	0	1	173.1848138	2.731848138
102	0	0	1	1	1	1	1	1	1	1	1	1		0	0	0	0	0	0	0	0	1	1	175.9166758	2.759166758
103	0	0	1	1	1	1	1	1	1	1	1	1		0	0	0	0	0	0	0	1	1	1	178.6758564	2.786758564
104	0	0	1	1	1	1	1	1	1	1	1	1		0	0	0	0	0	0	1	1	1	1	181.4626288	2.814626288
105	0	0	1	1	1	1	1	1	1	1	1	1		0	0	0	0	0	1	1	1	1	1	184.2772689	2.842772689
106	0	0	1	1	1	1	1	1	1	1	1	1		0	0	0	0	1	1	1	1	1	1	187.1200554	2.871200554
107	0	0	1	1	1	1	1	1	1	1	1	1		0	0	0	1	1	1	1	1	1	1	189.9912698	2.899912698
108	0	0	1	1	1	1	1	1	1	1	1	1		0	0	1	1	1	1	1	1	1	1	192.8911963	2.928911963
109	0	0	1	1	1	1	1	1	1	1	1	1		0	1	1	1	1	1	1	1	1	1	195.8201221	2.958201221
110	0	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	198.78	2.9878
111	0	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	0	201.7677972	3.017677972
112	0	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	0	0	204.7854724	3.047854724
113	0	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	0	0	0	207.8333243	3.078333243
114	0	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	0	0	0	0	210.9116547	3.109116547
115	0	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	0	0	0	0	0	214.0207685	3.140207685
116	0	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	0	0	0	0	0	0	217.1609734	3.171609734
117	0	1	1	1	1	1	1	1	1	1	1	1		1	1	1	0	0	0	0	0	0	0	220.3325803	3.203325803
118	0	1	1	1	1	1	1	1	1	1	1	1		1	1	0	0	0	0	0	0	0	0	223.5359033	3.235359033
119	0	1	1	1	1	1	1	1	1	1	1	1		1	0	0	0	0	0	0	0	0	0	226.7712596	3.267712596
120	1	1	1	1	1	1	1	1	1	1	1	1		0	0	0	0	0	0	0	0	0	0	230.04	3.3004

Fig. 3C

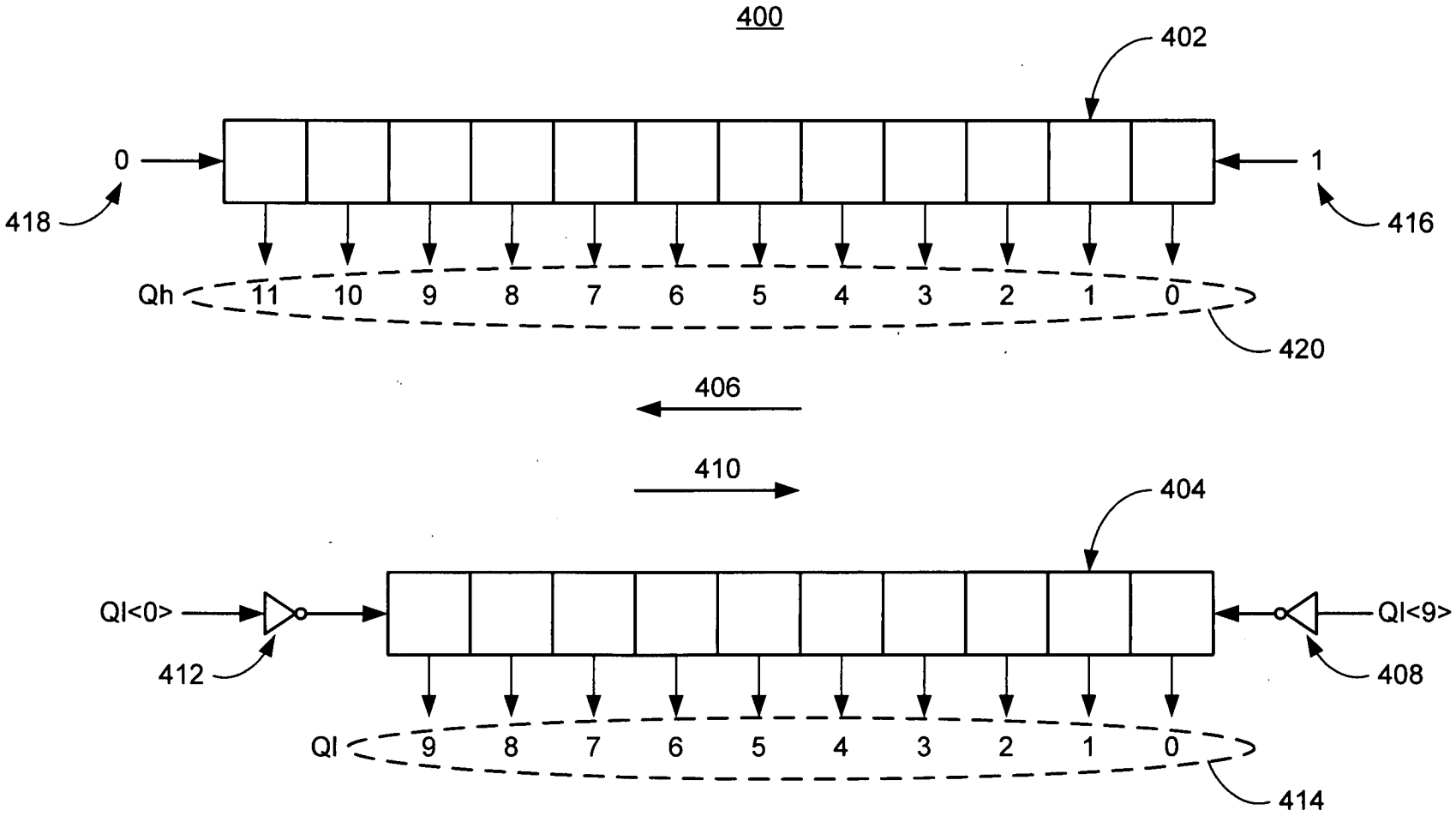
400
402
0
1
418
416
Qh
11
10
9
8
7
6
5
4
3
2
1
0
420
406
410
404
QI<0>
QI<9>
412
408
QI
9
8
7
6
5
4
3
2
1
0
414

FIG. 4